THE WORLD MAP BEFORE AND AFTER MAGELLAN'S VOYAGE

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FOUR hundred years ago, in April 1521, died Fernão de Magalhães, more familiarly known to Englishmen as Ferdinand Magellan, perhaps the greatest of the world's great navigators, the first to venture across the vast extent of the Pacific Ocean, and by so doing to virtually, if not actually, achieve the first circumnavigation of the globe. The man himself was worthy of the achievement, which was but the due reward of indomitable courage and determination, coupled with the highest seamanship and other fine qualities not always found united in the successful man of action.

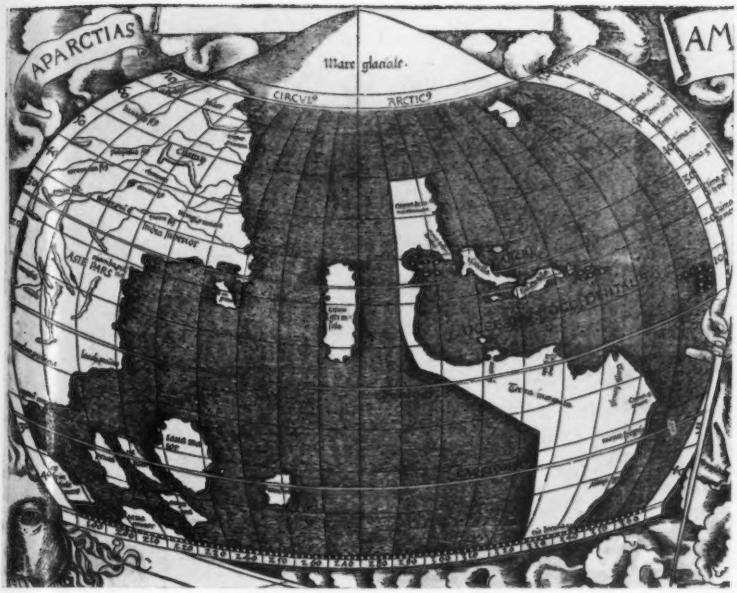
In this paper no attempt will be made to deal in a general way with Magellan's life and voyages. This has been admirably done by Dr. Guillemard in his well-known Life of the navigator, while the original narrative of the great voyage by Antonio Pigafetta has been made accessible in the English versions of Lord Stanley and Prof. Robertson; and a considerable foreign literature on the voyage is also in existence. The aim of the present paper, rather hurriedly put together as in some sort a commemoration of the quatercentenary on April 27, is a more modest one, concerned chiefly with one special aspect of the voyage—its relation to the geographical conceptions of the age in which it was made. By a survey of the most important cartographic documents before and after the voyage, an attempt will be made to bring out, first the influence on Magellan exercised by the ideas of his time, and next the influence of the voyage itself on the cartography of the time immediately following.

In any question relating to a possible circumnavigation of the globe, the views and theories of the early Greek philosophers still exercised great influence in the Age of Great Discoveries. The sphericity of the Earth had been fully accepted by the best Greek thinkers from Aristotle onwards, and it was held to be quite a possibility to reach India by sailing west from the Pillars of Hercules. This teaching had been greatly obscured during the dark ages, when the crude idea of a habitable world surrounded by the ocean, such as is illustrated by the map of Marino Sanuto (1321) and by many others, held sway over the minds of churchmen and the general public. Still it had never been quite lost sight of. The size of the Earth had been calculated by Eratosthenes (about 220 B.C.) at 250,000 stadia, which on the basis of 10 to the geographical mile, gave an equatorial circumference only about one-sixth more than the true measure. The habitable portion, from Spain to the end of India, was reckoned by him as 77,800 stadia on the parallel of Athens, on which the circumference was reckoned as about 200,000 stadia; so that the proportion of land to sea

(or at least of the known to the unknown) would be about as 1 : $1\frac{1}{3}$. This estimate was in excess of the true length of the Old World by about one-third. It may be noted here that the estimate of the distance to be covered by sailing over the unknown portion might be vitiated in two ways—first by mistakes in the calculation of the size of the Earth, secondly by mistakes in estimating the proportion between the known and the unknown. Now the exaggerated estimates of Eratosthenes were abandoned by his successors, who fell into the opposite error. Posidonius (first cent. B.C.), followed by Marinus of Tyre (second cent. A.D.) and his copyist Ptolemy, reduced the circumference to 180,000 stadia, giving only 500 to the degree instead of the 700 of Eratosthenes. But while thus reducing the whole circumference (in fact as a direct result of such reduction) Ptolemy overestimated the extent of the land area in degrees of longitude (his degree representing only five-sixths of its true measurement), and the error was enhanced by the overestimation of distances, even in stadia, by sailors and travellers. The longitudinal extension of Ptolemy's land area was thus fully 180° or half the circumference, from the Canaries to China, while it extended indefinitely beyond, since no termination was hinted at within the limits of the map. This representation of Ptolemy was of the greatest influence on the cartography of the time before Magellan.

On the revival by Columbus of the idea of the ancients that the east could be reached by sailing west (for it can hardly be doubted, *pace* M. Vignaud, that India was the goal kept in view from the first by the Genoese), these inaccurate ideas of the comparative smallness of the unknown ocean were even exaggerated by the acceptance of an Arab estimate of the size of the Earth, which seems to have reduced the length of the degree, as compared with Ptolemy's estimate, from $62\frac{1}{2}$ to $56\frac{2}{3}$ Italian miles. This gave a circumference only three-fourths of the reality.

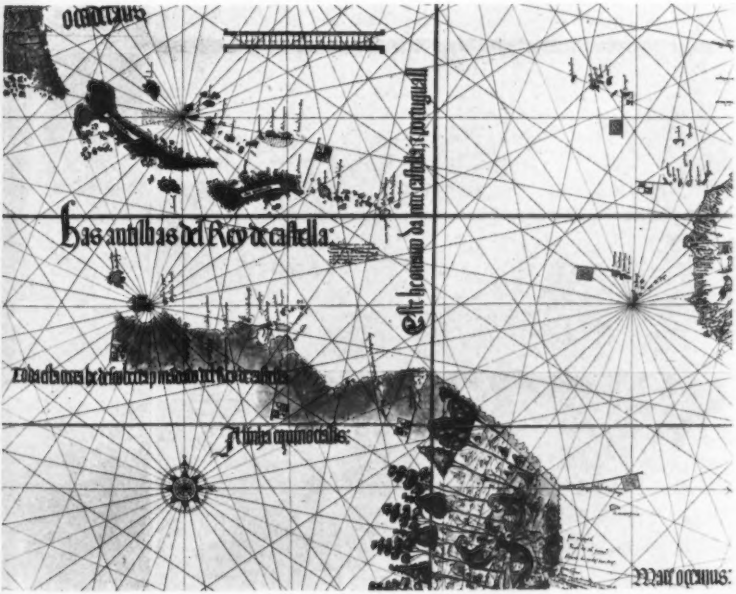
Next, as to the political conditions between Spain and Portugal, which affected Magellan's great enterprise. The venturesome voyages of the Portuguese under Prince Henry's inspiration had made known the whole coasts of West and South Africa down to and beyond the Cape of Good Hope, as well as the Atlantic groups of the Azores and Cape Verdes, before the voyages of Columbus, and the political rights of Portugal had been confirmed by Papal Bulls, which gave to that nation by anticipation all the lands that might be discovered "usque ad Indos." When therefore Columbus returned early in 1493 with news of discoveries beyond the Atlantic, the Spanish sovereigns lost no time in applying for similar rights from Pope Alexander VI. Much misconception has prevailed as to the precise scope and character of the successive Bulls promulgated with this object during 1493, but the true position has quite lately been admirably demonstrated by a Belgian writer, Prof. H. Vander Linden. So far from representing the award of an arbiter between opposing claims, the Bulls were merely grants made at the instance of, and in terms suggested by,



1. THE WESTERN HEMISPHERE, FROM THE INSET IN WALDSEEMÜLLER'S GREAT MAP OF 1507, SHOWING THE PACIFIC GREATLY REDUCED

(*From the facsimile by Fischer and Von Wieser.*)

The left half follows Behaim (see No. 4).



2. PORTION OF THE CANTINO MAP, 1501–2, SHOWING THE LINE OF PARTITION BETWEEN THE SPANISH AND PORTUGUESE SPHERES

(*From the facsimile accompanying Harrisse's 'Les Cortereal,'* 1883.)

3. THE CANERIO MAP, 1502, FROM DR. E. L. STEVENSON'S REPRODUCTION (MUCH REDUCED)

The ten sheets of the original combined into one.

one party only—Spain—by a pope who was, for private and political reasons, entirely subservient to the Spanish sovereigns. The binding nature of the grants was never recognized by the other party—Portugal—and it was by independent negotiations, in which the pope took no part at all, that the final arrangement was reached by the treaty of Tordesillas, signed the next year, 1494.

In one only of the four Bulls of 1493 (the second in order of promulgation) was any definite line of demarcation laid down, and this, which seems to have been suggested by Columbus himself, was rather of the nature of a boundary to a Spanish preserve—not to be overstepped by any person not authorized by the Spanish sovereigns—than a line of partition. Its terms were ambiguous (though not perhaps much more so than those of many modern treaties of delimitation), the line being described as running from pole to pole 100 leagues (the league was then four Italian miles) west *and south* of any island of the Azores and Cape Verde islands. It is impossible to attach any definite meaning to a *meridional* line running west and south of a given point, but the intention is fairly obvious. Columbus was then already planning a second voyage, hoping to extend his explorations southward. On the other hand, Portugal had put forward an excessive claim to everything south of Cape Bojador, which it was important to frustrate. The expression "towards the west and south" occurs three times in the same paragraph of the Bull. In two cases its use is quite justified as it is a case of *discoveries* to the west and south, but it seems to have escaped the draughtsman, in his desire to insist on the point, that in the third case the phrase was not strictly applicable. The starting point also has been variously interpreted, but the intention evidently was to give a clear interval of 100 leagues beyond the furthest outlier of either group.

Thus, although the partition of the world between the two Powers has been popularly ascribed to the pope, the idea is not strictly correct. Neither did the pope effect such a division in 1493, nor did the line then laid down really take effect at all, for the only arrangement accepted by both sides was that of the treaty of Tordesillas, signed 7 June 1494 after friendly negotiations. In this, to meet the views of Portugal, the line was drawn, not 100 leagues west of any island of either group, but 370 leagues west of the Cape Verdes, with no indication which island it was to pass through. The intention probably was once more to give a clear interval of 370 leagues west of the whole group, but the ambiguity naturally encouraged conflicting interpretations later. Even now attention seems to have been wholly directed to the Atlantic side of the globe, and nothing definite is said about the application of such a line to the Antipodes. At first the way seems to have been considered open to either Power to acquire rights in the Indies by virtue of discovery and occupation, and it was only later that the Atlantic line was tacitly taken as to be prolonged through the poles to the opposite side of the world.

In order to understand the conditions which impelled Magellan to his great undertaking it is necessary to glance at the course of events between 1494 and 1517. The later voyages of Columbus and other Spanish captains to the western lands had revealed the fact that here was a new world stretching from north to south and blocking any direct maritime route to the East Indies by the west. Meanwhile the Portuguese under Vasco da Gama had already gained the great object of their ambition and under Almeida and his successor Alboquerque had firmly established themselves on the west coast of India, had taken Malacca, the great emporium of trade on the west coast of the Malay peninsula, and under Abreu had pushed on among the rich and renowned islands of the Archipelago. An important though not a pre-eminent part had been taken by Magellan in these great doings. A Portuguese by birth, attached in his young days to the court of the king, he had early opportunities of mixing with the sea-captains and other adventurers, and in 1505, at the age of about twenty-four, had sailed to the east in the fleet of the viceroy, Almeida. During seven strenuous years he had borne his share in battles and hardships, but though many times wounded had suffered no serious disablement. He formed a close friendship with one Francisco Serrão, who commanded one of the ships in Abreu's voyage to the Archipelago, and, being wrecked on the return voyage, made his way to the famed Moluccas or Spice islands, where he remained for the rest of his life. His letters sent hence to his friend Magellan told of the wealth of those parts, and no doubt were the means of turning the serious attention of the latter to the Spice islands as a field for enterprise. Returning to Portugal Magellan afterwards served in Morocco, was once more wounded so as to become slightly lame for life, and, after friction with his superior officer, had the misfortune to incur the displeasure of the king. Unable on this account to obtain any chance of distinction by further service with his countrymen, he took the step, no unusual one in those days, of offering his services to the King of Spain (the Emperor Charles V.), having already for some time nourished the idea that the true road to the Spice islands would be by the western or Spanish route. Getting his scheme adopted in the end, he set sail on 20 September 1519, and, after passing safely through untold dangers and hardships in the passage through his strait and the trackless Pacific Ocean, met his death in the Philippines, in a fight due to a tragic error of judgment, on 27 April 1521, leaving to his subordinate Delcano the task of bringing one of the ships, the *Victoria*, safely home to Portugal by the Cape of Good Hope.

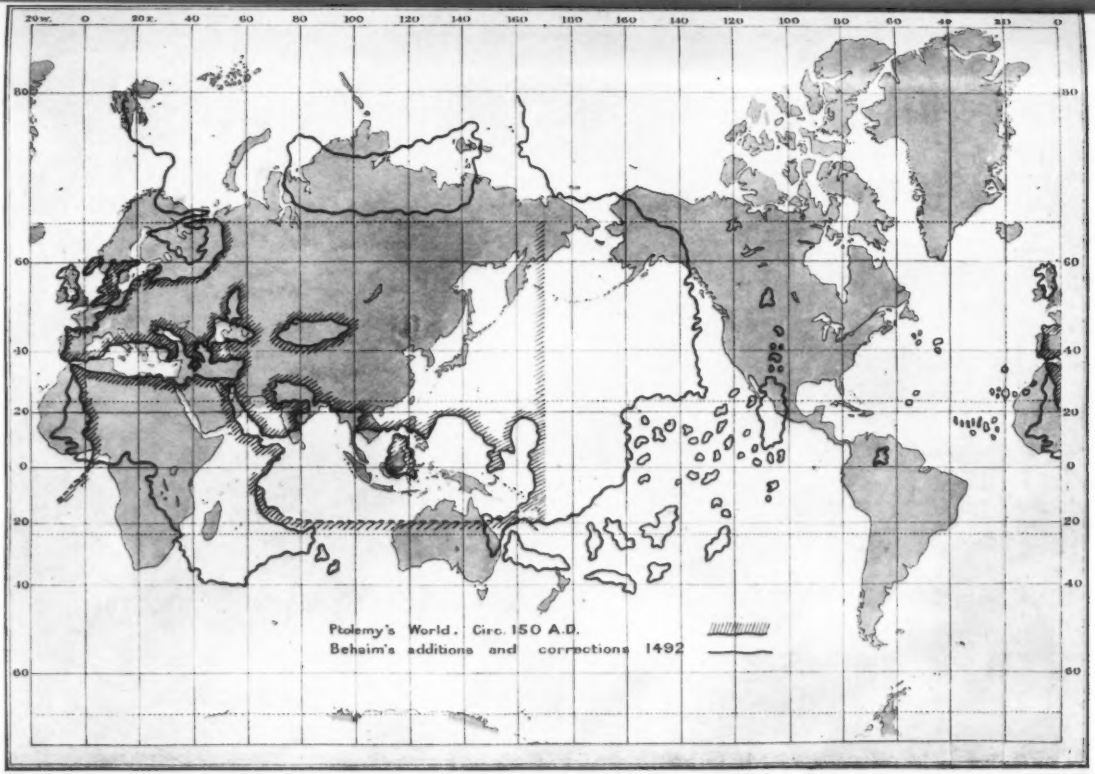
We may now consider the current ideas of World-Geography in the years before Magellan's voyage in the light of the cartography of the time. The documents that have come down to us are unfortunately but a tithe of those almost certainly once existing, those we know having in many cases been saved only through a happy chance. For the years following the first voyage of Columbus, though Spanish maps must certainly have

been made (and we have one most important one in that of Juan de la Cosa), some of the most striking maps known to us are of Portuguese origin. Before examining these we may glance at the maps current at the time of Columbus' great adventure and representing the notions accepted by him at his first setting out. They may be illustrated by a reconstruction of the so-called Toscanelli map, once thought to have supplied the main incentive to Columbus, but now considered to have had no connection with the Florentine astronomer, nor even to have been in existence at the date of the first voyage. It shows the whole space intervening between Portugal and the coast of China—in reality filled by the two great oceans and the whole breadth of North America—as occupying twenty-six spaces of 5° each—130° in all, in place of the actual 230°. Precisely the same scheme is to be found in Behaim's famous globe of 1492, of which Dr. Ravenstein's fine reproduction is exhibited in the Museum. In fact, the western part of the Toscanelli map has been reconstructed from Behaim. Behaim's representation of Eastern Asia is practically identical with that of Henricus Martellus, in the map of about 1489 preserved in the British Museum. Its most striking feature, reproduced in a host of later maps for over half a century, is the huge excrescence to the east of the Malay Peninsula, sometimes spoken of as a duplication of the latter, but really derived directly from Ptolemy, who, it will be remembered, drew a land-connection between eastern Asia and Africa, making the Indian Ocean a closed basin. It was now known that this was a mistake, but such was the reverence for Ptolemy's authority that his *Sinus Magnus* was retained and with it the further coast-line to the east, which Ptolemy had turned as it were on a pivot so as to run south and south-west instead of north and north-east. The eastern coast of this vast peninsula was now filled in by pure conjecture on the basis of Marco Polo, with the result that Asia—the longitudinal extent of which even up to the *Sinus Magnus* had been greatly exaggerated by Ptolemy—was still further extended eastward, leaving between it and western Europe the greatly diminished space already spoken of. That this representation marked a retrograde step is shown by the anonymous Genoese map of forty years earlier (1447), which, in spite of its generally crude construction, shows a far better apprehension of the geography of South-East Asia than many much later maps. A fine reproduction of this map is in the Society's collection. How the excessive extension of the old world held its ground even after the discovery of America is shown by the great map of Waldseemüller of 1507, and particularly by the inset map of the western hemisphere (Map No. 1). With America now intervening between Europe and eastern Asia, the space left for the unknown Pacific is reduced to a minimum—only 70° between the isthmus of Panama and the coast of China. In Ruysch's map of 1508 Asia is actually extended north-east to join the discoveries of Cabot and Cortereal in the North Atlantic.

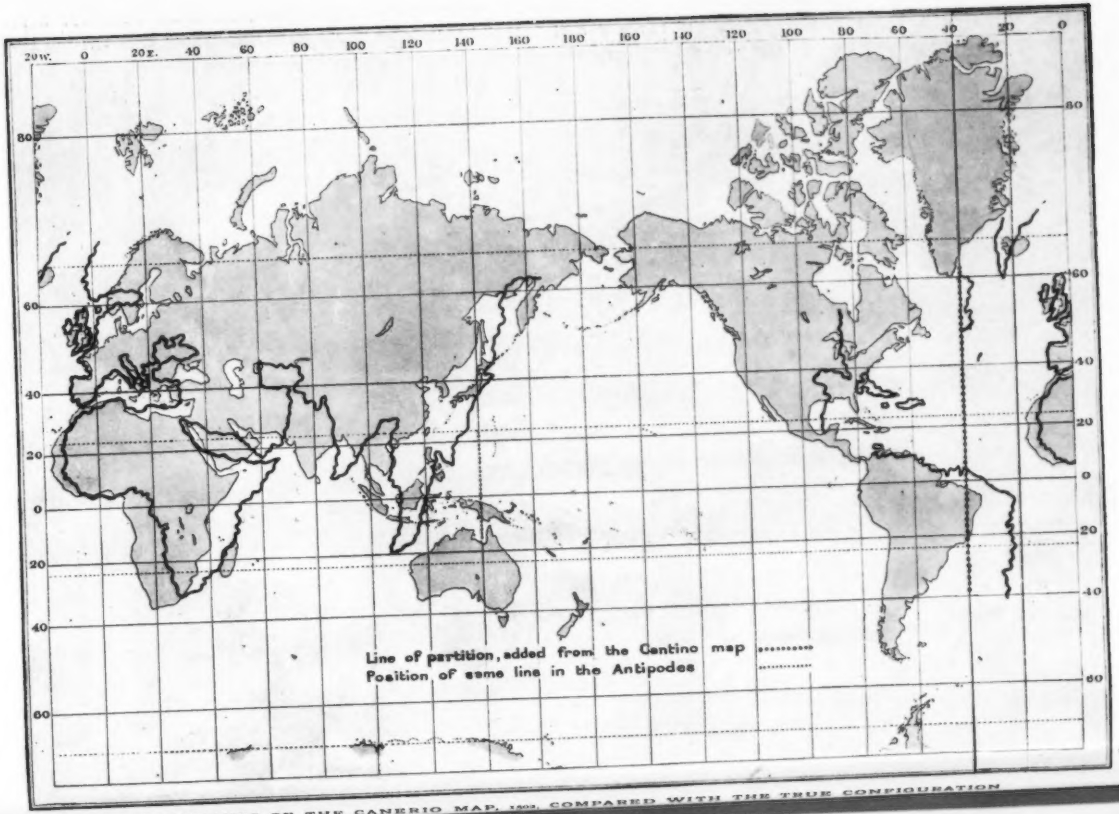
Of the improved Portuguese type of map that of Nicolo de Canerio,

a Genoese working from Portuguese originals, may be taken as representative (Map No. 3). Its probable date was 1502, but its sources were no doubt rather earlier. The great progress indicated by this map is at once apparent. The new maritime discoveries in Africa, Asia, and America all find a place, and for the first time the Indian peninsula appears in something like its true proportions. One of the most striking innovations is the departure from Ptolemy's exaggerated estimate of the longitudinal extension of the Old World. As in other marine charts, there is no scale of longitude, but one of latitude is provided, and we may suppose the same scale applicable to the longitude on the Equator; in any case it was so understood by Waldseemüller, who inserted the longitude scale in this sense in his *Carta Marina* of 1516, itself in the main copied from Canerio. On this basis we find the length of the Mediterranean reduced from Ptolemy's 60° to only 35°, or actually some 5° less than the reality. This reform (not generally accepted till many years later) was offset to some extent by an exaggeration of the longitude covered by eastern Africa and Arabia, involving a serious displacement of the axis of the Red Sea. On the other hand, the extent of the rest of southern Asia is so curtailed as to occupy only 46° in place of Ptolemy's 77°, again actually 5° less than the reality. The total reduction from the Strait of Gibraltar to the Malay Peninsula amounts to fully 40°—from 155° to about 114°, the correct figure being about 109°. Canerio's is the first serious attempt to represent the Malay Peninsula as it really is, with Malacca correctly placed on its west coast, though he exaggerates its size and southward extension. The map ends to the east at a line through China, and there is no trace of the south-eastern monstrosity which deformed so many maps. (Yet we find Waldseemüller in 1516, even when copying Canerio, still marking Ptolemy's *Sinus Magnus* to the east, and an almost contemporary map also attributed to him still shows the huge peninsula, so long were the makers of maps obsessed by a once-accepted tradition.) By thus curtailing the length of the Old World, and discarding the imaginary prolongation of Asia as well as the great islands strewn by other map-makers in the ocean to the east, the Canerio type of map greatly extended the space left to be covered by the Pacific Ocean, the great size of which must by this time have begun to dawn upon the minds of both sailors and geographers. It was even unduly extended on the American side in the Canerio map by the eastward shifting of the east coast of Brazil, as compared not only with the reality, but with the representation on other maps of the time. The unknown portion, from the east coast of Brazil to the Malay Peninsula, is thus made 25° more than the reality—225° instead of 200°. The accompanying outline-maps show the conceptions of (1) Behaim and his copyists; (2) Canerio, in relation to the actual facts (Maps 4 and 5).

We have next to consider the line of demarcation by the treaty of Tordesillas, as drawn by the cartographers of the period. It is most



4. THE WORLD ACCORDING TO PTOLEMY, WITH BEHAIM'S ADDITIONS AND CORRECTIONS, COMPARED WITH THE TRUE CONFIGURATION



5 OUTLINES OF THE CANERIO MAP, 1502, COMPARED WITH THE TRUE CONFIGURATION

explicitly shown in another map of the Canerio type—that known by the name of Cantino, the representative in Portugal of Hercules d'Este, Duke of Ferrara, for whom Cantino had it drawn. This map, a fine reproduction of part of which, brought out by Harrisse in 1883, is in the Society's Library, shows the line (labelled "Este he o marco da ntre Castella e Portugall") as cutting South America just east of the more easterly of the two great estuaries on the north coast, perhaps intended for the Gulf of Maranhão. It is difficult to reconcile this position with the 370° leagues west of the Cape Verde islands, as indicated by the scale of miles, suitably corrected for the latitude of the group, the line being not far enough from *any* island of the same. However this may be, the line no doubt represents the position of the boundary as accepted in Portugal at the time, and it is very similarly shown in a later Portuguese map, belonging to the School of the Reinels, of which a coloured reproduction was published by Kunstmann in 1859. If we transfer it to the Canerio chart it falls, according to the longitude numeration supplied by Waldseemüller, in 334° east (or 26° west) of the Canaries, and its continuation on the opposite side of the globe would fall in 154° E., or about 30° east of the central line of the Malay Peninsula. We may see here, perhaps, an indication of political motive, both in the curtailment of the length of the Old World and in the eastward shifting of South America, the result being to bring a larger share of the new discoveries within the Portuguese hemisphere. In the more usual type of map, which long continued to hold its own, in academic circles at least, the line through the Antipodes would run well to the west of the Malay Peninsula, leaving both this and all the archipelago to Spain. Even in the Canerio type of map the Spice islands—the great object of attraction in the far east—would fall only a little west of the boundary-line, and Magellan, who claimed them as within the Spanish hemisphere, seems to have found some support for his claim in other Portuguese maps, even of the nautical class. The most important of these after 1502 (of those now known to us) were made by the Reinels, father and son, and their school. Opinions differ somewhat as to their importance, one writer—Denucé—placing them quite in the forefront of the maps of the time, while the verdict of others is less favourable. In any case they are the earliest known maps to show the results of the first Portuguese voyage to the Archipelago—that of Antonio d'Abreu in 1511, in which Magellan is said to have taken part, and we are expressly told by Argensola that it was by a map of Reinel's that Magellan explained his scheme of a voyage to the Spice islands by the west to the Emperor Charles V. The Reinels were summoned to Spain in connection with the voyage, and seem to have at least directed the construction of the charts taken on board the ships. It is somewhat strange that whilst Canerio had discarded the *Sinus Magnus* and eastern peninsula of Behaim and others, Reinel still retains them in his Atlas of the Indian Ocean (about 1516), from the sheets of

which a combined chart has been drawn in outline by Denucé. For the parts of the east actually visited by the Portuguese there is a distinct improvement on Canerio, *e.g.* in the representation of both Indian peninsulas—the more easterly (the Malay) now correctly cut off north of the Equator—in the shape and position of Sumatra, and in the insertion of Java and the train of islands to the east visited by Abreu. The longitude of southern Asia is still more correctly given than by Canerio, if we may suppose the latitude scale to apply also to the longitude on the Equator. The intervals between C. Guardafui and the Malay Peninsula (53°) and between the latter and the Moluccas (24°) are both correct within a degree or so, such accuracy lending support to the idea that longitudes had here been fixed by observations of lunar eclipses. Unfortunately, as no longitude numeration is given, it is impossible to say just where the line of demarcation would have been drawn by Reinel, all depending upon the longitude of C. Guardafui accepted by him. Another map, made by the Reinels a year or so later, shows further improvement, especially in the greater width given to India, the better shape of Arabia, and the nearer approach to a correct representation of the Archipelago. Map No. 6 reproduces a part of this.

The formidable nature of the task involved by a circumnavigation of the globe must by this time have become fairly apparent, though not yet perhaps quite fully realized. Whilst Columbus was constantly imagining the countries reached by him to be those of eastern Asia, it soon came to be recognized, with the progress of exploration in Central and South America, that an independent land mass—the Mundus Novus of Vespucci—blocked any direct sea-route to the East Indies by way of the west, though many maps continued to indicate a strait in the locality of the Panama isthmus. Quite early in the sixteenth century the coast of South America had been traced beyond the La Plata estuary, and no passage had been found, though the globes of Schöner of 1515 and 1520, with the geographical treatises issued simultaneously, have led some to believe that at least the entrance to Magellan's strait had been discovered before his time. The development of the cartography of South America between the voyages of Columbus and Magellan is well brought out by a series of small outline maps, given by Dr. Ravenstein in his work on Martin Behaim. They show the gradual extension of the coast southward so as to form more and more of a barrier to one wishing to reach the east by the west, and also the great exaggeration by the map-makers of the longitudinal extension of the continent, which reaches a maximum in the version of Bartholomew Columbus, who actually joins South America to the east of Asia. This supposed extension westward would give encouragement to a navigator proposing to cross the Pacific, as affording a coast-line which might be followed for a considerable distance across the unknown area. Thus in the rough sketch-map attributed to Leonardo da Vinci only quite a small distance intervenes

between South America and Asia. An improvement on any of these maps is again shown by one made by the Reinels about 1516, which clearly marks the entrance to the Rio de la Plata, and is an excellent specimen of the artistic work of its authors (see Map No. 7).

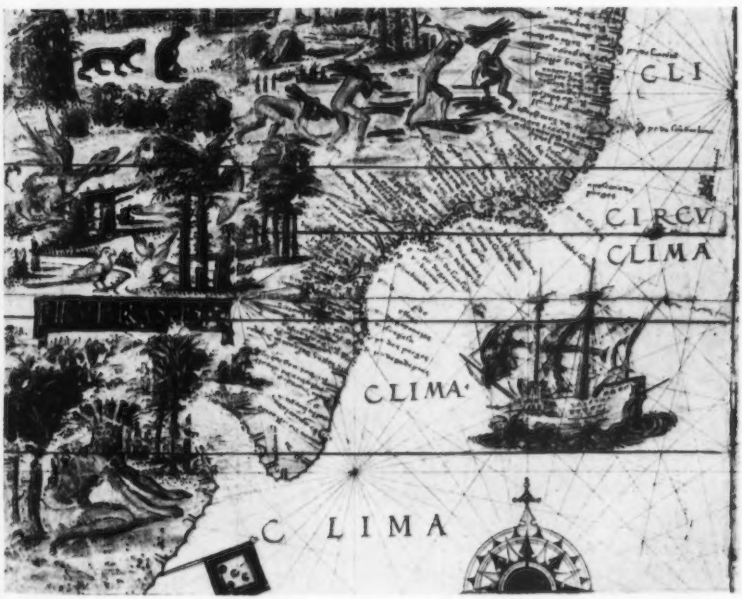
The globe-map of Schöner, already spoken of, supplies one of the chief arguments for the belief that the existence at least of Magellan's Strait had become known before the great voyage. The idea of such a strait is of course bound up with the belief in a southern land, which finds expression in various maps of the period. Such a land is shown, for example, in Leonardo da Vinci's map, though here it is placed much farther south than by Schöner. But the notion of an Antipodean continent, balancing, so to say, the known world of the northern hemisphere, dates back to a high antiquity, and recurs many times during the Middle Ages. It is to be found, *inter alia*, in the scheme of Pomponius Mela (first century A.D.). Some maps place a mythical southern land in the south of the Indian Ocean (possibly as an inheritance from Ptolemy). Such ideas had perhaps been fostered by imperfect knowledge of actual voyages to South America, and by the loose way in which the name Brazil (derived from the Brazil wood or verzino, known as a tropical product before the discovery of the modern Brazil) was applied to lands supposed to exist in the most widely separated localities. One of these was supposed to be not far from Malacca, whilst in the Lenox globe-map (one of Dr. Ravenstein's series) it is applied to the north-western extremity of South America. This is one of the maps showing a large land south of the Indian Ocean, and in the Cracow globe of about the same date (1511), the geography of which is in most respects identical with that of the Lenox globe, we have a strange instance of the confusion in some men's minds in the labelling of this supposed land as "America noviter reperta" (America lately discovered). It is worth noting perhaps that a somewhat similar confusion prevailed as to the part of the world reached by the French voyager, De Gonneville, some thinking that he touched at a part of South America, others that he had reached a new land in the Indian Ocean. Such confusion is further illustrated by the Association of parrots (specially mentioned by the early voyagers as found in Brazil, and prominently represented there on the Cantino and many other maps) with a vast land to the south of the Indian Ocean, where a legend recalling their great abundance is to be found in much later maps. Now when we find that the land south of Schöner's supposed strait likewise bears the name Brazil; remembering too that he was one of the academic rather than the practical school of map-makers; we can hardly give much weight to his representation as a proof of the knowledge of a strait, more especially as he places the passage some 7° N. of the true latitude of Magellan's Strait, in 45° instead of 52°. The idea of a strait giving access to the great South Sea had been in men's minds since the latter's discovery by Balboa, and when no such passage could be found within the

tropical part of America, it was not unnaturally transferred to the more southern region.

We come now to maps embodying the results of Magellan's voyage. The material is perhaps not so ample as might be wished, not only because some of the most important maps of the period have been lost, but because reproductions of some of those known are not generally available. One that is bound to be of interest in connection with Magellan is the large map by Juan Vespucci of 1526, or only four years after the return of the *Victoria*, brought to light by Messrs. Quaritch in 1914, and now in the possession of the Hispanic Society of America. The description published by Quaritch shows that it embodied the main results of Magellan's voyage, as might be expected from its author's official position in Spain as pilot and cartographer, but no reproduction of the map has yet been published. However, in the well-known Ribero maps of 1529, with the very similar map of 1527 sometimes attributed to Nuño Garcia of Turin, we have excellent examples of the official Spanish cartography during the decade following the great voyage. They were produced in the hydrographical office at Seville, established, according to some, largely under the direction of the Reinels, who seem for a time to have taken service under the Emperor. The accompanying Map No. 8 is a copy of the part of Ribero's map showing southern South America and Magellan's Strait. It could hardly be expected that the intricate navigation of the strait could be shown with greater accuracy, at least in a general map of the whole world. The left-hand portion of the map represents the Pacific, now first portrayed as a result of positive knowledge. The greater part is a mere waste of water, the only land seen for the greater part of the voyage being a few small islets, the chief of which received the names San Pablo and Tiburones ("I. of Sharks"). To the west of the ocean we see the Ladrones—the first landfall in that direction of Magellan as of so many subsequent navigators, and further still the eastern part of the Archipelago—representing the Philippines where Magellan met his death, the Spice islands with Jilolo, Banda, and Amboina, whilst in the other half of the map we have Timor, whence Delcano in the *Victoria* struck boldly south-west across the southern Indian Ocean to return to Europe by the Cape, and so complete the circumnavigation. This map is also important, as marking the line of demarcation through America, with Spanish and Portuguese flags on either side, and by the definite guide it thus gives to the position in which it would be placed on the other side of the globe in the view of the Spanish government. By this time the Portuguese were disposed to acquiesce in this view, and in 1529 (the date of this map) acquired the supposed Spanish rights to the Spice islands by purchase, though it was ultimately found that they were really Portuguese all through. On the accompanying sketch (No. 10) the outlines of Ribero's map are superposed on those of a modern map, showing that the width of the Atlantic was given

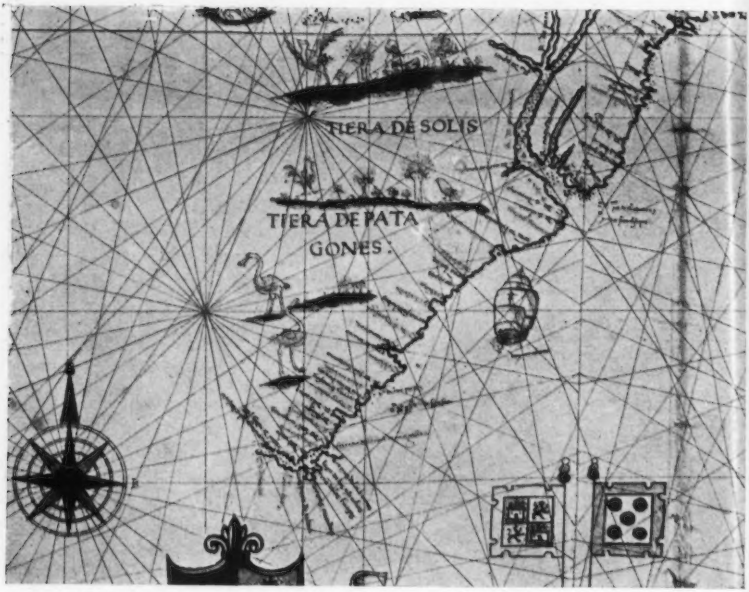
6. PART OF THE REINELS' MAP OF THE INDIAN OCEAN, CIRC. 1517, SHOWING THE RESULTS OF THE VOYAGE OF A. D'ABREU, 1511

The original extends somewhat farther east, and includes Jilolo.



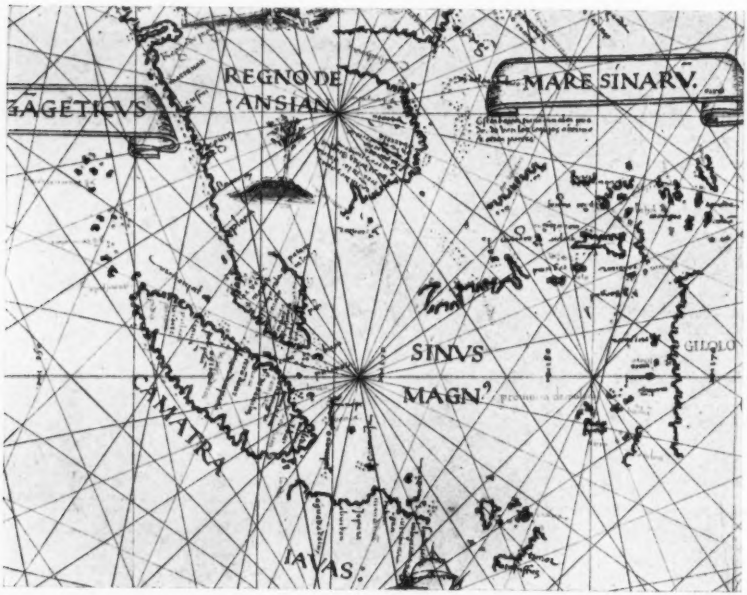
7. PART OF MAP OF SOUTH AMERICA, BY PEDRO AND JORGE REINEL, CIRC. 1516

(From Denucé's reproduction.)



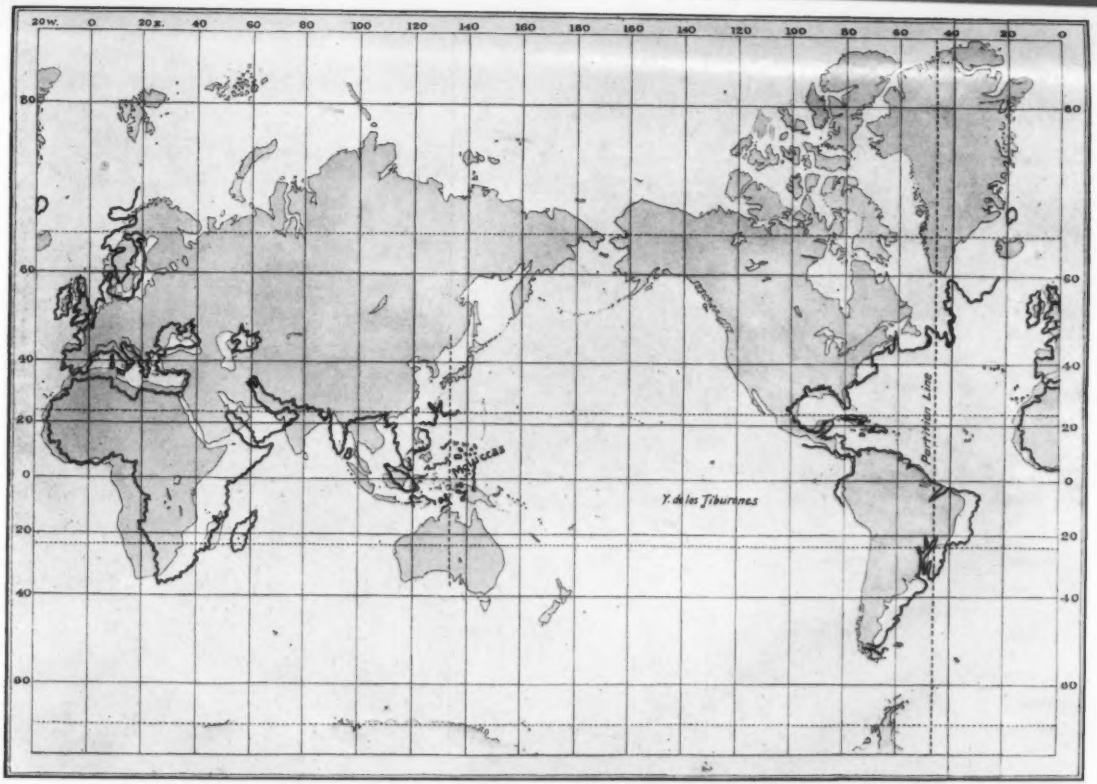
8. SOUTHERN SOUTH AMERICA AND MAGELLAN'S STRAIT FROM THE RIBERO MAP OF 1529. THE FLAGS INDICATE THE PARTITION BETWEEN SPAIN (TO THE WEST) AND PORTUGAL (TO THE EAST)

(*From the reproduction by William Griggs*, 1886.)

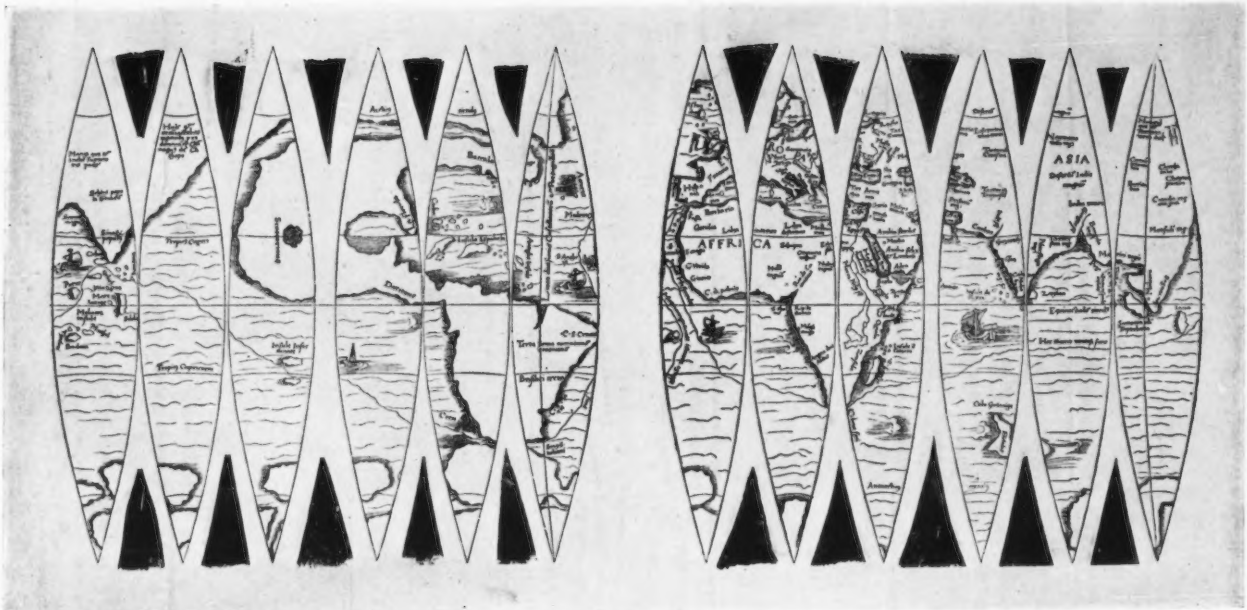


9. THE MALAY REGION IN THE RIBERO MAP OF 1529

(*From the reproduction by William Griggs*, 1886.)



10. OUTLINES OF THE RIBERO MAP, 1529, COMPARED WITH THE TRUE CONFIGURATION



11. GORES OF A GLOBE DOUBTFULLY ATTRIBUTED TO SCHÖNER, 1523, SHOWING MAGELLAN'S TRACK, AND THE LINES OF PARTITION IN BOTH HEMISPHERES

This Globe is copied in Holbein's picture, "The Ambassadors," 1533.

(From the facsimile in 'Johann Schöner' by Stevens and Coote, 1888.)

almost correctly (except in the north), but that the extension of the Old World was somewhat exaggerated, that of the Pacific somewhat reduced. Still the general correctness as regards longitude is certainly all that could be expected.

Another Spanish map, that of Alonso de Chaves compiled at Seville in 1536 as an authoritative version of all the new discoveries, is unfortunately lost, though a lately found Portuguese map by Lopo Homem, eighteen years later, is thought to represent it somewhat closely. Most of the maps of this official Portuguese cartographer are also lost, but, as Mr. Abendanon has shown in the *Geographical Journal*, probably gave a far better representation of the Malay Archipelago than any Spanish map of the time, the cartographical results of Magellan's voyage being but few as regards that Archipelago, apart from general world-maps like Ribero's. The best maps of the time for this part of the world are the French specimens of the Desceliers school, possibly based on Homem's.*

The next map (No. 11) is in the form of gores for a globe found at Munich in 1885, and described by the late Henry Stevens and C. H. Coote. It is interesting as actually showing the track of the *Victoria* round the world, as well as the lines of demarcation in the east and west. For a time it was thought to represent the lost globe made by Schöner in 1523, only the year after the return of the *Victoria*, but it has been shown pretty conclusively by Harrisse to be not the work of Schöner at all, and to be probably of somewhat later date. On the other hand, it has been shown by Miss Mary Hervey to have been the globe copied by Holbein in his picture of the Ambassadors, painted in 1533, so it is certainly no later than this date. By adhering to the academic representation of the Old World in longitude, it brings the whole Archipelago and part of the Malay Peninsula within the Spanish hemisphere, showing the maker to have been very much out of touch with actualities. Yet he errs in good company, for, strange to say, the official Spanish cartographer, Alonso de Santa Cruz, in his well-known map of 1542, so extends South-East Asia eastward that his "meridianus partitionis" in the East actually cuts the coast of Bengal just east of the Ganges, placing the whole of Further India in the Spanish hemisphere.

Whilst Ribero confined himself to actual discoveries and thus left blank the whole of the Pacific area not covered by Magellan's track, it was otherwise with other maps of the time. If the belief in a southern continent prevailed as it did before the great voyage, it seemed to gain confirmation from Magellan's passage through his strait, the island of Tierra del Fuego being taken for merely the northernmost extremity of the

* By the courtesy of Messrs. Quaritch the maps shown at the meeting included an interesting and undescribed MS. chart of the Archipelago, based in part on Magellan's voyage, and marking the supposed spot in the Philippines (themselves designated by the name given by Magellan—Archipelago de San Lazaro) where he met his death. It is unsigned and undated, but may perhaps belong to the class of lost Portuguese maps to which Mr. Abendanon has drawn attention.

supposed continent, which looms out in a more and more imposing form in the maps of the next half-century. We can here mention one or two only. The double heart-shaped map by the French geographer Oronce Finé brings it prominently into view by reason of the projection chosen, and marks it as "Terra Australis recenter inventa sed nondum plene cognita" (the Southern land lately found but not yet fully known). A part is still labelled Land of Brazil and another Regio Patalis, a legend which some have thought a corruption of the Land of Parrots of other maps, but which seems to be an inheritance from much older times. The Pacific has nothing like its correct extension, only 100° intervening between Magellan's Straits and Jilolo next the Moluccas (it should be at least 160°)—one more instance of the slowness of academic map-makers to adopt the results of practical men. The southern continent also figures prominently in the group of maps of the Dieppe school, by Desceliers and others, in which the makers have given further rein to their fancy by joining it to the "Great Java" in the region where Australia was ultimately to be found. The excellent representation of the islands of the Archipelago may here be noted. The great Southland is also a marked feature in all the maps of the Flemish school—*e.g.* in the World-map of Ortelius, one of those in which the abundance of parrots on the Southland is specially mentioned. The parts north of the Pacific, too, long continued to offer a field for speculation, and the belief first expressed in 1508 by Ruysch that North America was but the continuation of Asia to the north-east held its ground long after Magellan's voyage. An instance is the map of the Italian cartographer Gastaldi, in which America and Asia are joined in quite low latitudes, as they were also by Finé. It was not till towards the end of the eighteenth century that the separation of Asia from America was finally established by Bering.

Magellan's voyage left in fact much to be filled in—the whole Australian region as well as the whole of the lands on either side of the Northern Pacific. In spite of this a fairly correct idea of the relative extension of land and sea had now been gained, and in this respect no decided improvement on maps like Ribero's was reached till the time of the French geographer Delisle, nearly two centuries after the great voyage.

Before the paper the PRESIDENT said: It is very meet that we should come together from time to time to celebrate the great deeds of those who have gone before us, and who have laid the foundations of our science. This afternoon we celebrate the fourth centenary of that great circumnavigator, Magellan. Mr. Heawood will not give an account of his great voyage, but he will show in what way that voyage affected the map of the world. I will ask Mr. Heawood, who has, at brief notice but with great care, compiled a paper upon the changes in the map before and after Magellan's time, to give us his lecture.

Mr. Heawood then read the paper printed above, and a discussion followed.

Sir BASIL THOMSON: It must have struck everybody, I think, in listening to the paper, how curious it is that so many of the voyagers in the Pacific

managed to miss the greater groups. Magellan took a course which was afterwards taken by many other voyagers, and if you look at the map of the Pacific you will see he could not have devised his course better if he wanted to avoid dangers and get to the Philippines. You have voyage after voyage from 1525 onwards. Some of these voyages were disastrous because the crews mutinied. In 1537 you have Grijalva: one ship out of the expedition managed to get to New Guinea. In 1542 you have Villalobos; in 1555 Gaetano, and there is rather a curious history about him. He was the pilot to Villalobos's expedition, and in 1555 he discovered Hawaii; it is so believed owing to the finding of an old chart which is marked with the words "discovered by Juan Gaetano." In 1565 Lopez de Legaspe discovered the route to the Philippines, and we really owe to the voyage of 1567 the remarkable fact it was possible in those days to run an annual galleon to the Philippines with almost the accuracy of a Pacific liner. The reason was this. When Mendaña set out in 1567 and discovered the Solomon Islands he took the same kind of course. He found the Solomon Islands and there came the fatal day in the islands when he called a council of all his officers and suggested that they should set sail westwards like the remaining ships of Magellan's expedition. The pilots voted against it. If they had sailed westwards, in all probability Mendaña would have discovered Australia in 1567. It was almost chance that he did not. He left the Solomons and tried to work to the south-east. Then the crew nearly mutinied, and he consented to go north. He crossed the Pacific far north of the line, and when eventually he reached California, within two days his second ship, long believed to have been lost, arrived at the same anchorage. Anybody who has knocked about the Pacific in a sailing ship will realize what an extraordinary feat that was. It was the sailing north that made it possible to run the galleon. You cannot get back under sail unless you go north and pick up a north-west wind on the way back. This voyage illustrates the vicissitudes of geography. After the discovery of the Solomon Islands the tavern talk was that the islands were full of gold. There was no foundation for this beyond the fact they had discovered some stone-headed clubs rich in pyrites. Eventually they persuaded the Government to fit out a fresh expedition in 1595. Mendaña had placed the Solomon Islands 1500 miles nearer to Peru than they really were, and he discovered the Marquesas and Santa Cruz, and when he got to Santa Cruz he came to the conclusion that the New Hebrides were the Solomons. He died there, and the expedition went away north of the Solomons. The Solomon Islands then began to travel almost all over the Pacific. I think they were identified with the Marquesas, and even Dalrymple in 1790 denied their existence as separate from New Britain. They were re-discovered in 1767 by a Frenchman, Buache, just two hundred years after they had been lost. It was very interesting that several people visited them, but it remained for the man at the study table, and not the discoverer, to identify them. Years after they had been re-discovered a Frenchman sat down and re-established the fact that the Solomons had been re-discovered two hundred years after they had been lost.

Mr. GLANVILL CORNEY: As one who has experienced the thrill of handling some of the original documents written by men who sailed in the ships of Magellan's days, it is with particular pleasure, though not without much diffidence, that I avail myself of your invitation to add a few words to the very lucid and important paper which we have just heard from Mr. Heawood. I will refer only to one aspect of those discoveries, one which has reference not so much to the East Indies as to the Strait. For many years after Magellan had

passed through the Strait from east to west very little use was made of it, and not until thirty-seven years afterwards was it ever explored from west to east. But at that time Ladrilleros and another navigator or pilot called Ogea, whose manuscripts I have seen, were appointed to sail from Valdivia down the coast of Chile and Patagonia, and explore the strait Magalhães had discovered, from west to east. But it was very little used by shipping either from west to east or east to west for many years, although one or two expeditions were sent out from Spain to survey it. It was felt to be too remote, and its navigation was too dangerous. The climate was too rigorous, and the time occupied was such that the crews were very apt to be overtaken by scurvy, and altogether it did not serve the practical needs of the ships of that time; so that at least four projects for facilitating the conveyance of people and merchandise across the isthmus of Central America were presently discussed. One route crossed from Nombre de Dios; to Panamá one through the isthmus of Nicaragua and across the lake; another through the isthmus of Tehuantepec; and one from the north side of Darien to the gulf of San Miguel. But the more interesting point to which I would now refer is that it was really the discovery of Magalhães' strait, and the difficulties that were found to attend its passage by ships, that laid the foundation for the great modern triumph of engineering that we see to-day in the Panama canal in full working order. In 1527 steps were taken to clear the impediments in the bed of the Chagres river from its mouth up to the head of the navigable portion, which was a distance of about 12 leagues, and it was found that from that point to the coast on the Panama side involved a cart road of another 7 or 9 leagues. As an alternative to this plan proposals were submitted to the Emperor Don Carlos V. for the canalization of this track, and in 1534 His Majesty actually directed that the locality should be surveyed with that object in view—that a report should be drawn up and submitted to him setting forth the most suitable and economical means for establishing a communication between the head of the navigable portion of the river and the ocean on the west, the difficulties likely to be met with in executing such a work, whether on account of different tides, as was suggested by some people, or by reason of the irregularities in the surface of the land and its levels. His Majesty further called for a careful estimate of the expenses that the scheme to be most recommended would entail in men and money, and desired to be informed of the time that its execution might be expected to occupy. So that we have to go back to the year 1527 to get at the first suggestion for the construction of a canal across the isthmus of Panama; and that was a direct result of Magalhaes' discovery. The despatch embodying these commands from the Emperor was dated 20 February 1534, and was immediately sent out to the Governor of Panama. The Governor at that time was Don Pascual de Andagoya, and he viewed this proposal with disfavour; but while promising to see the orders of the Emperor carried out as far as practicable in the course of the ensuing spring, he considered that His Majesty must have been advised by counsellors of little talent, and persons who had no knowledge whatever of the local conditions or climate or topography. He even assured the Emperor that the world contained no prince, howsoever puissant, equal to the task of uniting the two seas, even with the aid of the native inhabitants of the country. Some persons deprecated the idea because, they alleged, the levels of the Atlantic and the Pacific were not the same; saying that the first effect of a canal would be to flood the adjacent countryside. Fifty years later Padre José de Acosta, the historian of the Indies of that date, observed that be that as it might, it merely seemed to his poor ability that no human agency could suffice to break through

the mighty wild of rocky fastnesses and the impenetrable forests that God had set between ocean and ocean, and which had continued for untold ages to successfully resist the fury of their waves. What might the good Padre not have said could he have been present to witness, the other day, the passage of His Majesty's ship the *Renown*, bearing upon her decks the world's most puissant Prince, quitting the waters of the Atlantic to-day and entering those of the Pacific to-morrow!

Sir ALBERT GRAY: One of the sad experiences of advancing years is that we find what we were taught in our youth as facts become dispelled subsequently as myths and illusions. I had such an experience a week or two ago reading a most interesting book entitled 'Russia in the 'Eighties' by Mr. Baddeley, and there one of my illusions was dispelled. I had been told in my youth that in Russia wolves used to attack travellers in packs, and I remember well such a scene in a picture with the pack of wolves surrounding a sleigh and the unfortunate occupants tossing out their remaining food in order to get rid of the wolves. Now Mr. Baddeley comes along and tells us that this is a mere myth—that the wolves do not go about in packs, but roam in ones and twos. Mr. Heawood disperses another of those myths, and we now are told that it is entirely an error to suppose that the Pope Alexander VI., as an arbitrator, divided the world between Spain and Portugal by an imaginary line. One is rather loath to give up this illusion, but it seems to me there is just a trifle of reason in the foundation for it. One must admit that Pope Alexander did not act in the matter exactly as an arbitrator, his decision being given solely on the claim of Spain, and the awards to Portugal having been made by previous popes. Both the Portuguese and the Spaniards seem to have considered that to have a Papal Bull in your pocket was a fairly good title-deed. Accordingly first the Portuguese went to Rome, and obtained a Bull giving them all the discoveries as far as the Indies. Then the Spaniards came to Pope Alexander, and he gives them, apparently, the first Bull of 1493 confirming to them (under conditions) the discoveries of the Western ocean. Somebody seems to have brought it to the pope's notice immediately after the Bull was issued that this might interfere with the previous Bulls in favour of Portugal, and accordingly the very next day (if the Bulls were in fact issued on the dates assigned to them) the second Bull was promulgated fixing the 100-league limit, so although the pope gave those Bulls not as an arbitrator, but as a supreme authority, yet he was bound to consider that the various Bulls should not be inconsistent; and therefore he did what was the nearest thing to arbitrating between the two Powers, and fixed the 100-league limit. That decision, as we know, was unsatisfactory to Portugal, and the result was the Treaty of Tordesillas in the following year. I cannot claim to offer any observations on the actual history of cartography as has been so lucidly explained to us to-day by Mr. Heawood and in the speeches of my friends Sir Basil Thomson and Dr. Corney, but it occurs to me as an outsider how extremely probable it is that when an imaginary land gets on to a map it remains there for a long time before it is finally got rid of, and also that these various maps were probably not made in large numbers, and that in some cases the map-maker would know perhaps some only of the discoveries and not others. I only wish to thank Mr. Heawood most heartily for his most interesting and lucid paper.

The PRESIDENT: It made one's mouth water to see the series of maps which were put on the screen, and to note the number of blank spaces there were upon them which needed exploration. Nowadays there are very few blank spaces left, and we geographers are hard put to it to know where to go.

But four hundred years ago, in Magellan's time, one can imagine the joy with which those old sea captains put their heads together and thought over the great voyages which might be possible. To-day we would like to put once more on record the grateful memory in which we hold the magnificent services which Magellan rendered to geography. Mr. Heawood has well shown both what there was to be discovered, the amount of unknown sea and land in his time, and what his voyages enabled cartographers to fill in, and I am sure you would like me to thank on your behalf Mr. Heawood for collecting so many interesting facts regarding the great work of Magellan.

FOUR NOTES ON MAP PROJECTIONS

Read at the Afternoon Meeting of the Society, 14 March 1921.

Note on a Doubly-Equidistant Projection

Colonel Sir CHARLES CLOSE, K.B.E., F.R.S., Director-General of the Ordnance Survey

WE most of us know that when it is desired to ascertain from a small-scale map or atlas the distance between two points, the only correct way is to find from the map the latitude and longitude of the points and make a small calculation. But in practice, owing to the weakness of mortal nature, nobody does this, and we take a scale or pair of dividers and measure the distance between the points. It occurred to the writer that it might be interesting to acknowledge this human failing, and to choose a map projection in which the two straight-line distances between any arbitrary point and two previously fixed points should always be correct. The two fixed points may be, for instance, the starting and ending points of a voyage, and on such a projection, however the traveller may deviate from the shortest path, he will always be able to find, by direct measurement, how far he is from his home and how near to his goal.

It at once follows, from the definition of the projection, that the great circle joining the two fixed points is represented by a straight line true to scale throughout its length. Having drawn this straight line, the construction of the projection is easy: for each point of known latitude and longitude calculate the spherical or spheroidal distances to the fixed points, and the intersection of these rectified distances, measuring from the fixed points, will give the position of the required point on paper. The two systems of small circles, of which the two fixed points are the poles, are represented by concentric circles spaced at their true rectified distances.

In the special case in which the Pole of the Earth is one of the fixed points, the parallels of latitude are represented by concentric circles spaced at their true distances. The meridian passing through the other selected point is represented by a straight line true to scale throughout its length. As regards the other meridians, if the latitude of the other fixed point,